

Passive Films for CubeSat Solar Array and Radiator Thermal Control (ALD - Atomic Layer Deposition)

Completed Technology Project (2015 - 2016)



Project Introduction

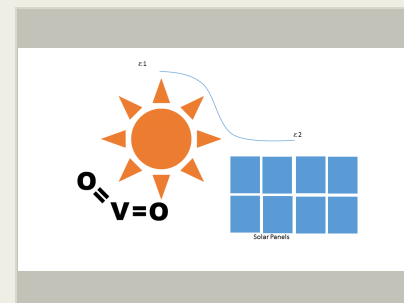
Trending towards reduced power and mass budget on satellites with a longer mission life, there is a need for a reliable thermal control system that is more efficient and cost-effective. Vanadium dioxide, VO_2 , is a transition metal oxide that undergoes a passive thermal phase change from a semiconductor to a metal at 67 C. By depositing nm thick VO_2 via an in house atomic layer deposition (ALD) reactor, passive thermal control for solar cells, radiators and external boxes with minimized weight, cost and structural simplicity is possible. By utilizing a combinatorial property of atomic layer deposition where layers of other materials such as alumina or zinc oxide can be deposited in conjunction with vanadium oxide to provide a dopant in order to reduce the transition temperature.

ALD is a cost effective nanoadditive-manufacturing technique that allows for the conformal coating of substrates with atomic control in a benign temperature and pressure environment. Through the introduction of paired precursor gases, thin films can be deposited on a myriad of substrates from flat surfaces to those with significant topography. By providing atomic layer control, where single layers of atoms can be deposited, the fabrication of metal transparent films, precise nano-laminates, and coatings of nano-channels and pores is achievable.

The benefit of using a variable emissive coating has been verified via a thermal model where we assume two plates, 100 mm x 100 mm at 1/8" thick, orbiting LEO in safe mode at a Beta 0 angle allowing for maximum eclipse. If we coat one plate with the variable emissive coating and the other with silver Teflon we see that the variable emissive coating maintains a much warmer temperature versus the constant high emissive silver Teflon coating. These results translate to a 2 W savings in heater power if both plates are to run at similar temperatures.

Anticipated Benefits

As miniaturized science platforms continue to be an integral part of NASA's missions in the form of CubeSats, novel thermal control methodologies must be applied such that they do not burden the mass and power budget while allowing for an extended mission lifespan.



Using vanadium dioxide deposited by ALD for variable emissive films

Table of Contents

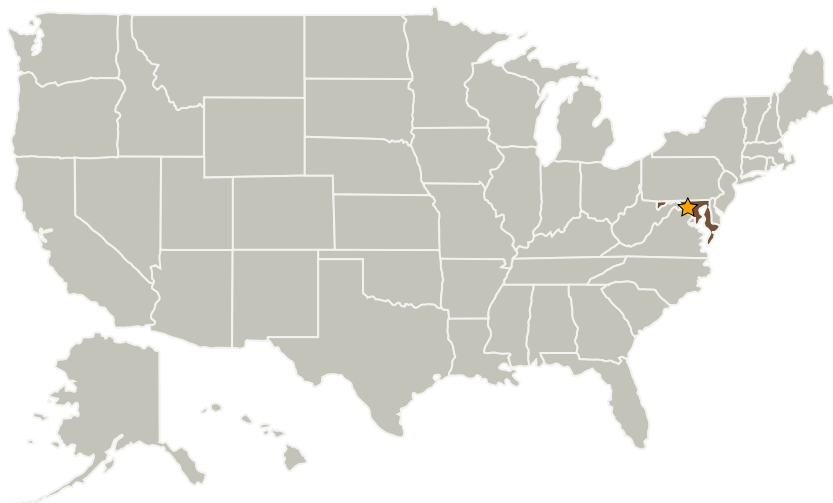
Project Introduction	1
Anticipated Benefits	1
Primary U.S. Work Locations and Key Partners	2
Organizational Responsibility	2
Project Management	2
Technology Maturity (TRL)	2
Images	3
Project Website:	3
Technology Areas	3

Passive Films for CubeSat Solar Array and Radiator Thermal Control (ALD - Atomic Layer Deposition)

Completed Technology Project (2015 - 2016)



Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★ Goddard Space Flight Center (GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland

Co-Funding Partners	Type	Location
University of Maryland-College Park (UMCP)	Academia	College Park, Maryland

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

Michael J Viens

Principal Investigator:

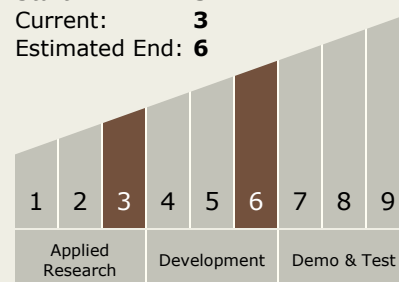
Vivek H Dwivedi

Technology Maturity (TRL)

Start: 3

Current: 3

Estimated End: 6

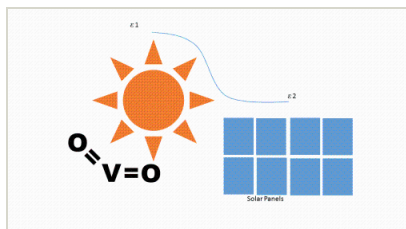


Passive Films for CubeSat Solar Array and Radiator Thermal Control (ALD - Atomic Layer Deposition)

Completed Technology Project (2015 - 2016)



Images



Technology Illustration

Using vanadium dioxide deposited by ALD for variable emissive films
(<https://techport.nasa.gov/image/19317>)

Project Website:

<http://aetd.gsfc.nasa.gov/>

Technology Areas

Primary:

- TX14 Thermal Management Systems
 - └ TX14.2 Thermal Control Components and Systems
 - └ TX14.2.3 Heat Rejection and Storage